FIG. 1

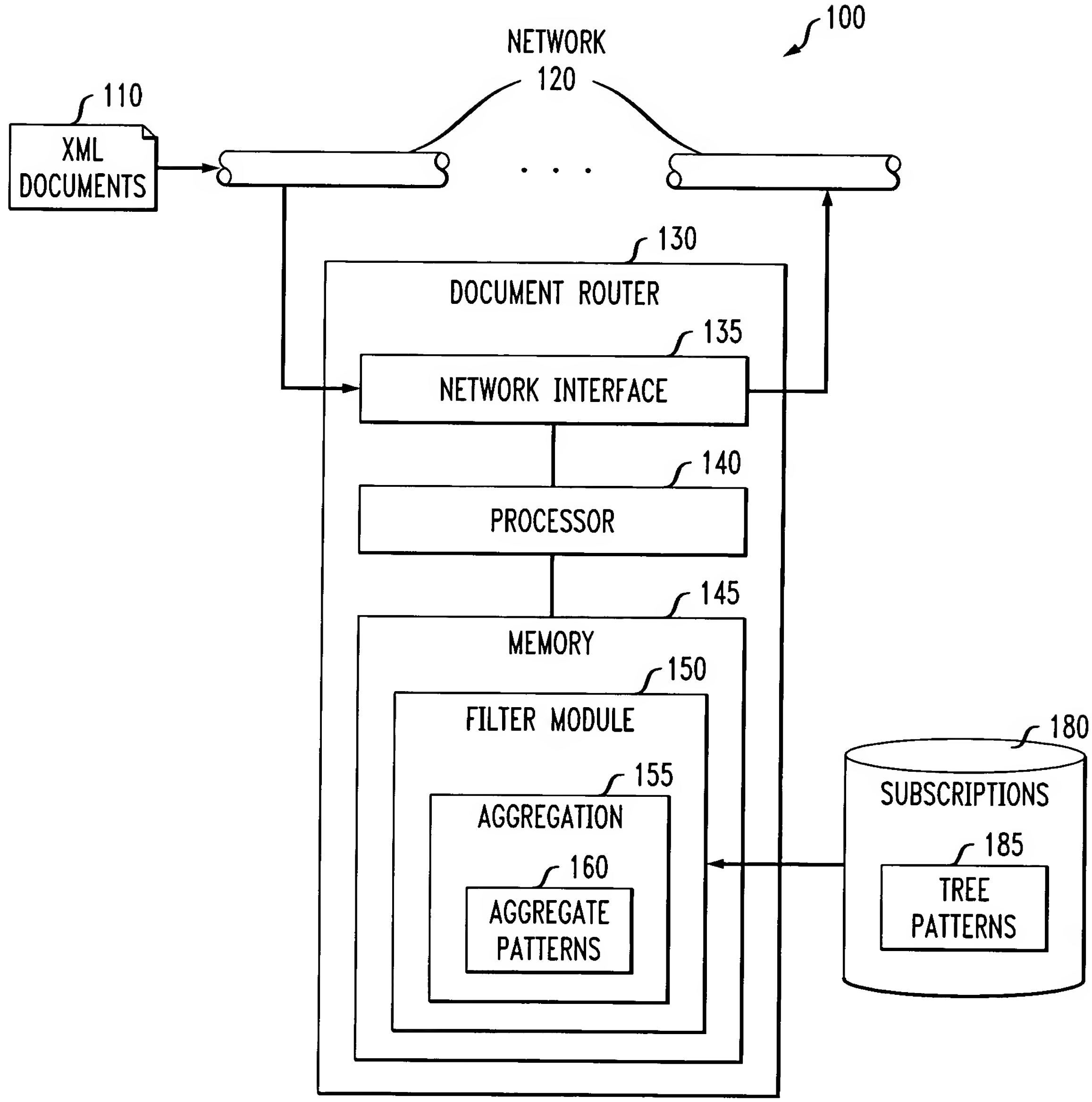

100
NETWORK
120
110
XML DOCUMENTS
130
DOCUMENT ROUTER
135
NETWORK INTERFACE
140
PROCESSOR
145
MEMORY
150
FILTER MODULE
155
AGGREGATION
160
AGGREGATE PATTERNS
180
SUBSCRIPTIONS
185
TREE PATTERNS

FIG. 2A

P_a

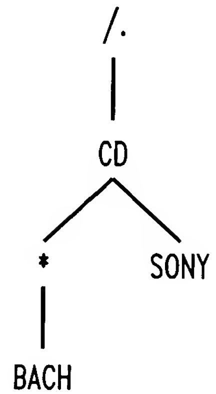


FIG. 2B

P_b

FIG. 2C

P_c

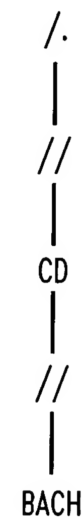


FIG. 2D

P_d

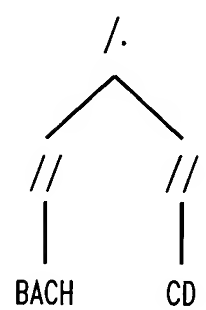
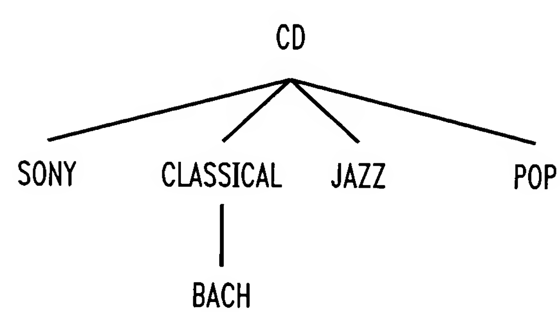


FIG. 2E

T



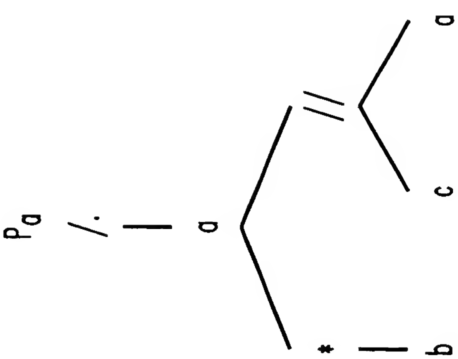


FIG. 3A

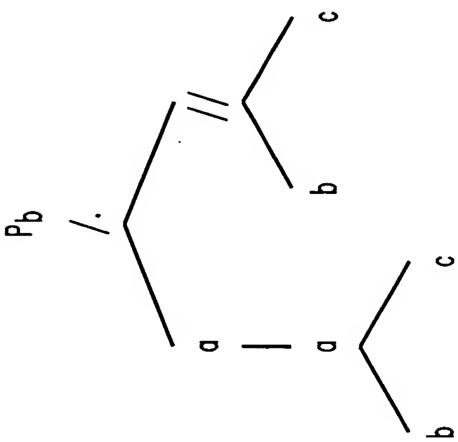


FIG. 3B

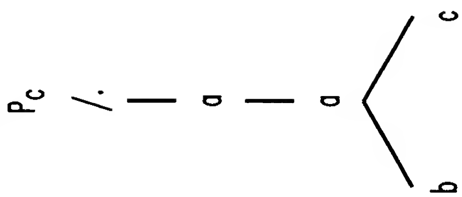


FIG. 3C

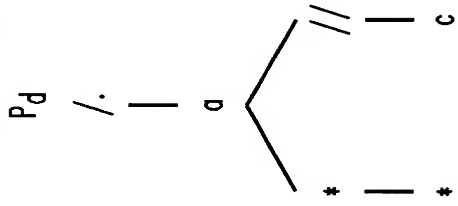


FIG. 3D

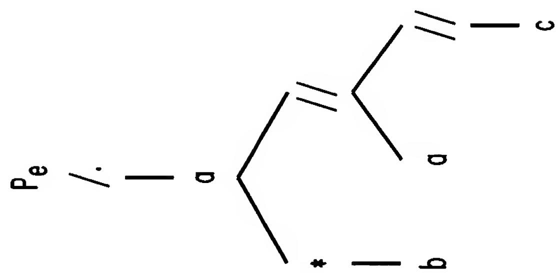


FIG. 3E

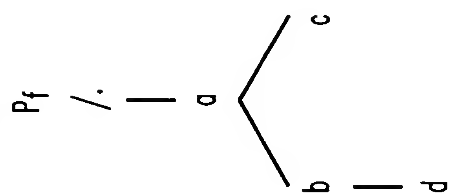


FIG. 3F

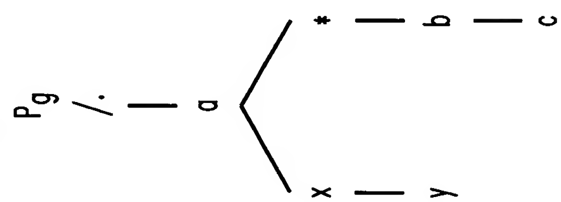


FIG. 3G

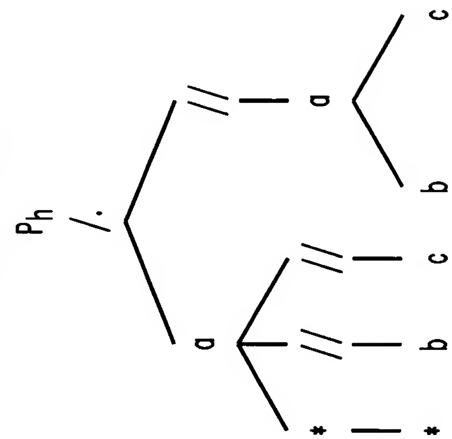


FIG. 3H

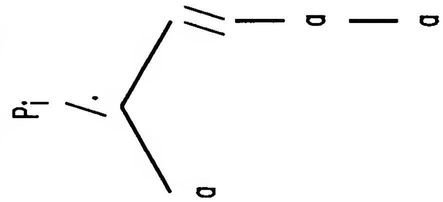


FIG. 3I

FIG. 4A

METHOD LUB (p, q)
Input: p and q are tree patterns.
Output: A tree pattern representing the LUB of p and q.
1) **if** $(q \sqsubseteq p)$ **then** return p;
2) **if** $(p \sqsubseteq q)$ **then** return q;
3) Initialize $TCSubPat[v, w] = \emptyset$,
   $\forall v \in Nodes(p), \forall w \in Nodes(q)$;
4) Let v_{root} and w_{root} denote the root nodes of p and q, resp.;
5) **for** each $v \in Child(v_{root}, p)$ **do**
6)   **for** each $w \in Child(w_{root}, q)$ **do**
7) $TCSubPat[v, w]$ = LUB_SUB $(v, w, TCSubPat)$;
8) Create a tree pattern x with root node label /. and
   the set of child sub-patterns
$$\bigcup_{v \in Child(v_{root}, p),\, w \in Child(w_{root}, q)} TCSubPat[v, w];$$
9) **return** MINIMIZE (x);

FIG. 4B

```
METHOD LUB_SUB (v, w, TCSubPat)
Input: v, w are nodes in tree patterns p, q (respectively),
       TCSubPat is a 2-dimensional array such that
       TCSubPat[v, w] is the set of tightest container
       sub-patterns of Subtree(v, p) and Subtree(w, q).
Output: TCSubPat[v, w].
1) if (TCSubPat[v, w] ≠ ∅) then
2)     return TCSubPat[v, w];
3) else if (Subtree(w, q) ⊑ Subtree(v, p)) then
4)     return {Subtree(v, p)};
5) else if (Subtree(v, p) ⊑ Subtree(w, q)) then
6)     return {Subtree(w, q)};
7) else
8)     Initialize R = ∅; R′ = ∅; R″ = ∅;
9)     for each v′ ∈ Child(v, p) do
10)      for each w′ ∈ Child(w, q) do
11)          R = R ∪ LUB_SUB (v′, w′, TCSubPat);
12)    for each v′ ∈ Child(v, p) do
13)      R′ = R′ ∪ LUB_SUB (v′, w, TCSubPat);
14)    for each w′ ∈ Child(w, q) do
15)      R″ = R″ ∪ LUB_SUB (v, w′, TCSubPat);
16)    Let x be the pattern with root node label MaxLabel(v, w)
         and set of child subtree patterns R;
17)    Let x′ be the pattern with root node label //
         and set of child subtree patterns R′;
18)    Let x″ be the pattern with root node label //
         and set of child subtree patterns R″;
19)    return TCSubPat[v, w] = {x, x′, x″};
```

FIG. 5A

METHOD CONTAINS (p, q)
Input: p and q are two tree patterns.
Output: Returns *true* if $q \sqsubseteq p$; *false* otherwise.
1) Initialize $Status[v, w] = null$,
$\forall v \in Nodes(p), \forall w \in Nodes(q)$;
2) Let v_{root} and w_{root} denote the root nodes of p and q, resp.;
3) **if** $(Child(v_{root}, p) = \emptyset)$ **then**
4) **return** *true*;
5) **else**
6) **return** CONTAINS_SUB $(v_{root}, w_{root}, Status)$;

FIG. 5B

METHOD CONTAINS_SUB (v, w, *Status*)

Input: v, w are nodes in tree patterns p, q (respectively),
Status is a 2-dimensional array such that each
$Status[v, w] \in \{null, false, true\}$.

Output: $Status[v, w]$.

1) **if** $(Status[v, w] \neq null)$ **then**
2) **return** $Status[v, w]$;
3) **if** (v is a leaf node in p) **then**
4) $Status[v, w] = (label(w) \preceq label(v))$;
5) **else if** $(label(w) \npreceq label(v))$ **then**
6) $Status[v, w] = false$;
7) **else**
8) $Status[v, w] =$

$$\bigwedge_{v' \in Child(v, p)} \left(\bigvee_{w' \in Child(w, q)} \text{CONTAINS\_SUB}(v', w', Status) \right);$$

9) **if** $(Status[v, w] = false)$ **and** $(label(v) = //)$ **then**
10) $Status[v, w] =$

$$\bigwedge_{v' \in Child(v, p)} \text{CONTAINS\_SUB}(v', w, Status);$$

11) **if** $(Status[v, w] = false)$ **and** $(label(v) = //)$ **then**
12) $Status[v, w] = \bigvee_{w' \in Child(w, q)} \text{CONTAINS\_SUB}(v, w', Status)$;
13) **return** $Status[v, w]$;

FIG. 6A
T1

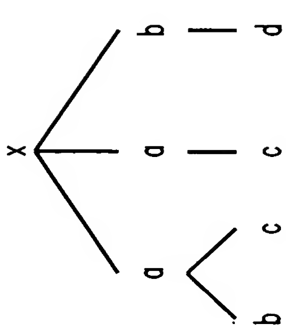


FIG. 6B
T2

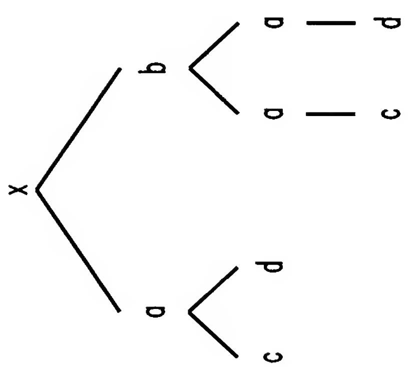


FIG. 6C
T3

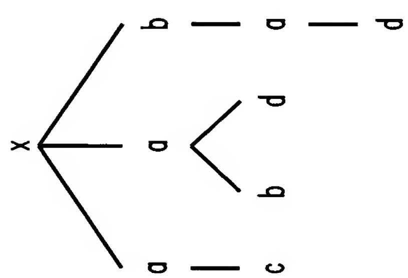


FIG. 6D
SKELETON TREE FOR T1

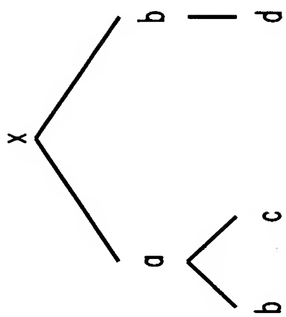


FIG. 6E
DOCUMENT TREE

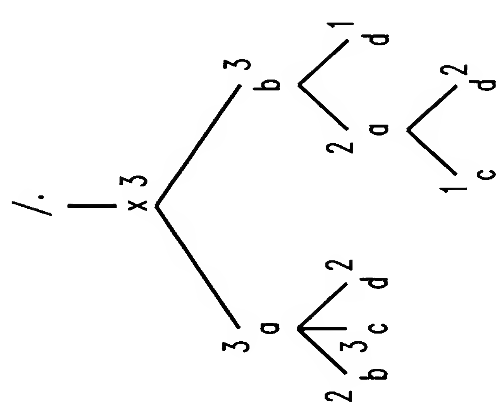


FIG. 6F
COMPRESSED DOCUMENT TREE

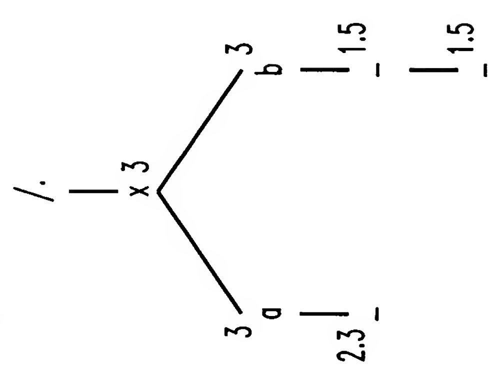


FIG. 6G
p1

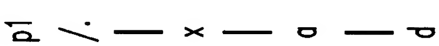


FIG. 6H
p2

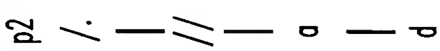


FIG. 6I
p3

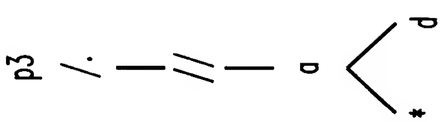


FIG. 7

METHOD SEL(v, t)
Input: v is a node in tree pattern p, t is a node in DT.
Output: $SelSubPat[v, t]$.
1) **if** ($SelSubPat[v, t]$ is already computed) **then**
2) **return** $SelSubPat[v, t]$;
3) **else if** ($label(t) \not\preceq label(v)$) **then**
4) **return** $SelSubPat[v, t] = 0$;
5) **else if** (v is a leaf) **then**
6) **return** $freq(t)/N$;
7) **for** each child $v_c \in Child(v, p)$ **do**
8) $Sel_{vc} = max_{t_c \in Child(t,DT)} \{\mathrm{SEL}\ (v_c, t_c)\}$;
9) $Sel = \prod_{v_c \in Child(v,p)} Sel_{vc}$;
10) **if** ($label(v) = //$) **then**
11) $Sel_v = \prod_{v_c \in Child(v,p)} SEL(v_c, t)$;
12) $Sel = \max\{Sel, Sel_v\}$;
13) $Sel_v = \max_{t_c \in Child(t,DT)} \{\mathrm{SEL}(v, t_c)\}$;
14) $Sel = \max\{Sel, Sel_v]$;
15) **return** $SelSubPat[v, t] = Sel$

FIG. 8

METHOD AGGREGATE (S, k)

Input: S is a set of tree patterns, k is a space constraint.

Output: A set of tree patterns S' such that $S \sqsubseteq S'$ and $\sum_{p \in S} |p| \leq k$.

1) Initialize $S' = S$;
2) **while** $(\sum_{p \in S'} |p| > k)$ **do**
3) $C_1 = \{x \mid x = \text{PRUNE}(p, |p| - 1), p \in S'\}$;
4) $C_2 = \{x \mid x = \text{PRUNE}(p \sqcup q, |p| + |q| - 1), p, q \in S'\}$;
5) $C = C_1 \cup C_2$;
6) Select $x \in C$ such that $Benefit(x)$ is maximum;
7) $S' = S' - \{p \mid p \sqsubseteq x, p \in S'\} \cup \{x\}$;
8) **return** S';